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APPLICATION NOTE **AP-103**

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Programming E²PROM With a Single 5-Volt Power Supply

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The Intel 2816 is a new generation of non-volatile memory in which writing and erasing can be accomplished on board by providing a 21 volt pulse. Figures 1 and 2 show the wave forms for byte erase (or write) and chip erase respectively. In order to generate the V_{PP} pulse, a power supply with output voltage of +24V is needed. In a system environment where this voltage is not available, a switching regulator can be used to convert +5V into +24V. This Application Note will discuss the design and implementation of such a regulator.

With the advent of LSI technology, the design of a dc-to-dc converter has been greatly simplified. Figure 3 shows the circuit diagram for a voltage converter using a TL497 switching voltage regulator. The converter presented here is very low cost and is excellent for use in systems where 5 volts is the only supply available.

In order to familiarize the reader with the operation of such a converter, the following discussion is appropriate. The circuit operates as follows: the frequency at which transistor Q1 is switching is determined by capacitor C1. The converter output voltage is fedback to an internal comparator that controls the on and off time of Q1. When Q1 is turned off, voltage across the inductor inverts, and the blocking diode CR1 is forward biased to provide a current path for the discharge of the inductor into the load and filter capacitors (C2 and C3). During the time when Q1 is turned on, the current into the inductor increases linearly. The blocking diode CR1 will become reverse biased and the output load current is provided by the filter capacitors. Figure 4 shows the waveform of the current into the inductor when the output is drawing 80mA. As can be seen, there is no gap between the charge and discharge cycles. Therefore, any current output exceeding 80mA will cause the output voltage to start losing regulation. The switching regulator efficiency can be calculated as a ratio of output power to input power. Therefore,

$$\% \text{ efficiency} = \frac{\text{Output power}}{\text{Input power}} \text{ X } 100\%$$

$$= \frac{24\text{V X } 80\text{mA}}{5\text{V X } 1160\text{mA X } 0.5} \text{ X } 100\%$$

$$= 66\%$$

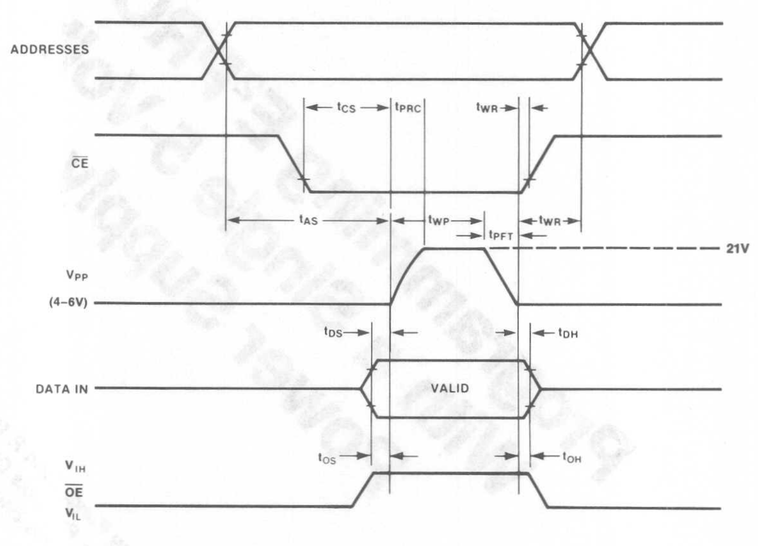

Figure 1. Byte Erase (or Write) Waveforms

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The output voltage from the switching regulator can now be used to generate the V_{PP} pulse required to program the 2816 E^{2}PROM. Figure 5 shows the V_{PP} switch circuit diagram. CR1 is used to suppress any noise on the +24V. A2 is an open-collector gate. When its output is low, C1 and pin 5 of A1 will be shorted to ground. Therefore, Q1 will be turned off and V_{PP} pulse will stay at V_{CC} less one diode drop. When a write cycle is initiated, output of A2 will be high for 10mS. This would allow the capacitor to charge. The time constant is determined by R1 X C1 = 600μsec. As soon as the voltage across the capacitor is charged up to the zener voltage, the feedback amplifier will force this voltage to remain constant. The final output voltage is adjusted by R2. Q1 provides the additional current drive capability up to 75mA and CR2 across pin 5 and 6 of A1 will ensure a glitchless V_{PP} pulse.

The 2816 has an inhibit mode which allows the device to be deselected during programming. It also means that the V_{PP} switch has to supply the I_{PP} standby current for the unselected devices. Table 1 shows the maximum number of devices that can be supported by the switching regulator in an 8-bit and 16-bit system. Because of the inhibit mode device selection, only one switch is needed for many devices in system.

The dc-to-dc converter and V_{PP} circuit provide an overall solution for programming the 2816 E^{2}PROM using a single +5V supply. With its high current drive capability, the V_{PP} switch should satisfy over 95% of the design requirements. Therefore, it is recommended that the circuit be implemented whenever +24V is not available. This circuit has also been designed and tested to operate over the full temperature range, just like the 2816.

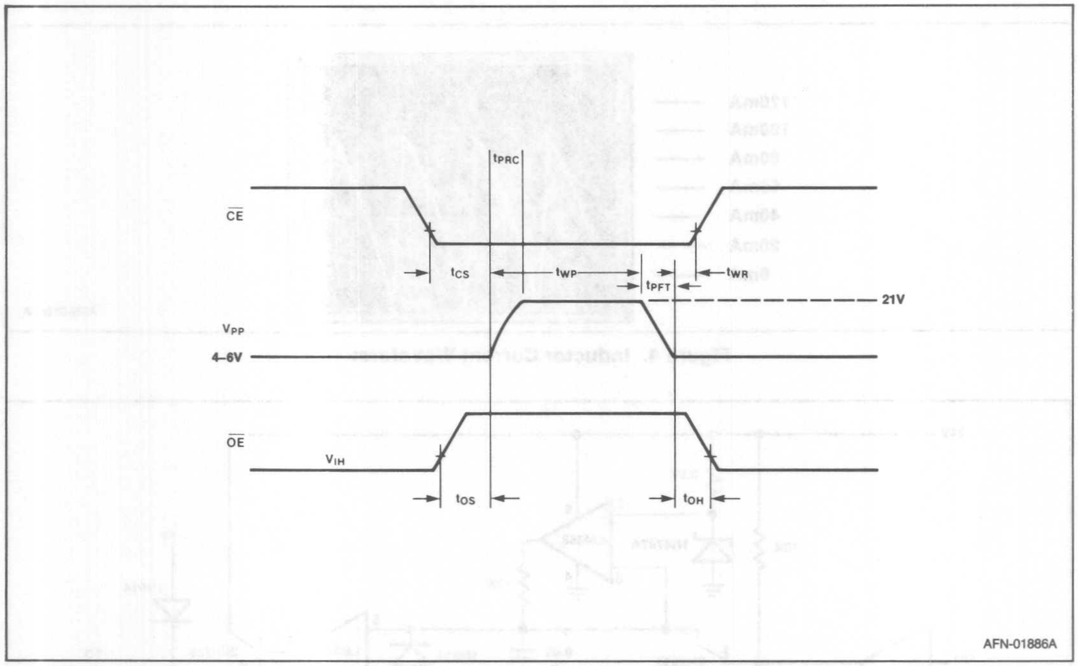

Figure 2. Chip Erase Waveforms

Table 1.

System	Active Programming Current	Standby Current	Devices Supported	K Bytes
8-bit	15mA	60mA	13	26
16-bit	30mA	45mA	10	20

NOTE: Total current (I_{PP}) = 75mA.

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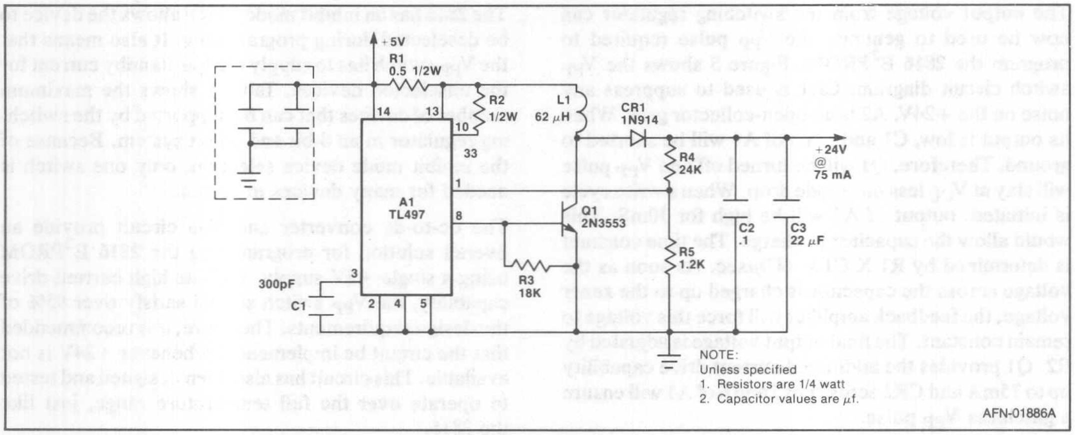

Figure 3. Step-Up Regulator Converts +5V into +24V

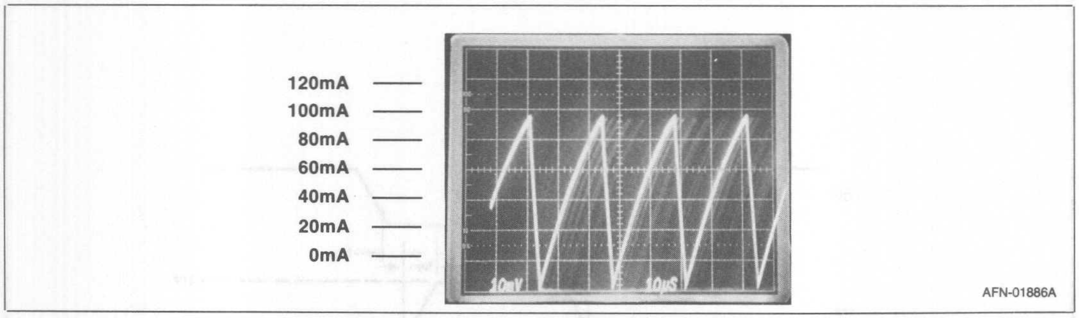

Figure 4. Inductor Current Waveform

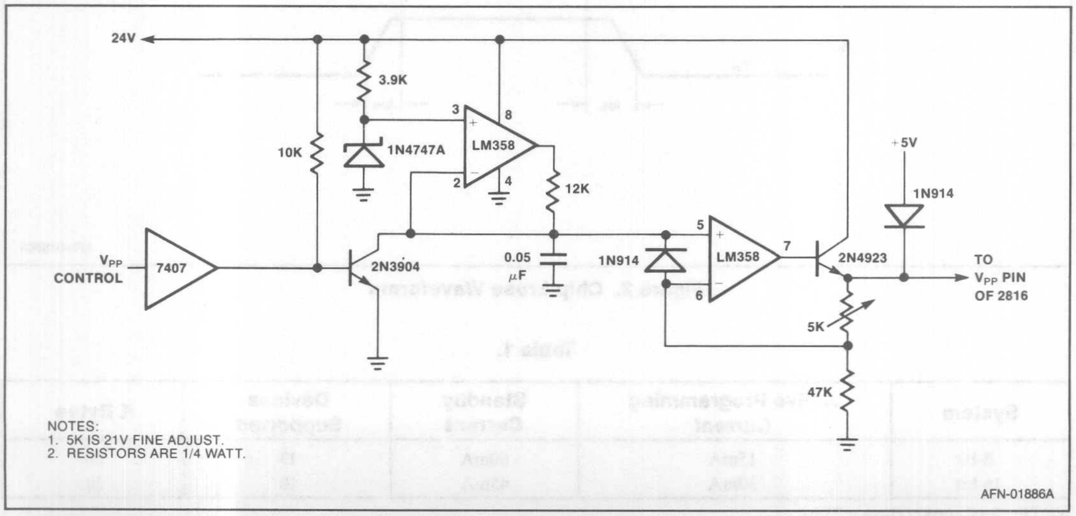

Figure 5. V_{PP} Switch